Applicants wish to express their gratitude to Examiner Bell for the courtesies be extended their representative during an interview on January 29, 2003.

Applicants note that the title has been amended above to correct a grammatical error. Additionally, the amendments to the paragraphs on pages 33 and 41 shown above were previously made in a Preliminary Amendment dated August 21, 2001. However, in that Preliminary Amendment, the page and line number references were incorrect. Thus, in the interest of maintaining a complete and accurate record, Applicants have resubmitted the amendments with references to the correct line and page numbers.

It should be noted that many of the amendments to the claims above have been made for the sake of clarity, and not for purposes of patentability. For example, the amendments made to the allowed claims, 94-96, and the allowable claims, 83 and 85, have been made strictly for purposes of clarity and not for reasons relating to patentability. Likewise, other claims have similarly been amended for better clarity, and in some cases to correct grammatical errors.

The Claims are Patentable over *Iwata*

Independent claims 77, 86, and 97 stand rejected under 35 U.S.C. § 102(a) as being anticipated by the article entitled "Artificial Reality With Force-Feedback: Development of Desktop Virtual Space With Compact Master Manipulator," by Hiroo Iwata (*Computer Graphics*, Vol. 24, No. 4, August 1990) (hereinafter "*Iwata*"). Applicants respectfully traverse this rejection for the reasons set forth below.

The present invention is directed to controlling simulated objects via a force feedback mechanism that provides force feedback. To provide realistic feedback, a path of a simulated object is determined based upon prior positions of that object, and simulated objects are prevented from penetrating or passing through one another, even if their trajectory (i.e., path), or the motion of a user-controlled device, would indicate that they should pass through one another.

For example, independent claim 77, which is directed to processor-executable code, recites "code to determine a trajectory of [a] first simulated object associated with a prior position of the first object." Independent claim 86 recites "determining whether [a] first graphical object has engaged a second graphical object based on a path of the first graphical

object associated with a prior position of the first graphical object." Independent claim 97 recites "computing a path of [a] first graphical object based on at least a prior location of the first graphical object." Independent claim 97 also recites "determining whether the first graphical object has collided with a second graphical object based on the path of the first graphical object."

Iwata, on the other hand, describes a relatively simplistic force feedback system for manipulating virtual objects using real world controls. *Iwata*, however, fails to disclose or suggest determining a trajectory of an object based upon prior positions of that object, or determining, based on such a trajectory or movement of physical controls, whether penetration of a virtual object would occur.

The Office Action is silent regarding determining a path of a simulated object based on prior positions of that object, which was originally contained in Claim 94 that was allowed in the prior Office Action.

Regarding displaying a first object engaged with the surface of a second object, even if its path passes through the second object (i.e., the first object's path indicates it should pass through the second object), as recited in claims 86 and 97, for example. The Office Action states that Section 3.2 and Figure 11 of *Iwata* somehow suggests this feature. It is unclear, however, from an inspection of this figure, or the related text of Section 3.2, that *Iwata* has contemplated such a situation. Indeed, *Iwata* simply fails to disclose or suggest determining a path or trajectory of virtual objects. Rather, Figure 11 merely illustrates the various forces that need to be applied to a physical force feedback object to give a user a realistic feeling of holding a camera. Thus, the various vectors illustrated in Figure 11 relate to forces, and not to paths or trajectories of simulated objects.

As indicated above, each of the independent claims, as amended, recites determining either a path or trajectory of a simulated object based upon a prior position in one form or another. Although the claims vary in how they determine or compute this path, each of the approaches is not disclosed or suggested by *Iwata*. Additionally, independent claims 8 and 97 recite simulating such objects as being unable to penetrate one another, even if their paths or the motion of a physical force feedback object would indicate that they should penetrate one another.

Although each of the claims differs in how this simulation occurs, such simulation generally is not disclosed or suggested in *Iwata*.

Accordingly, for at least these reasons, Applicants respectfully request the withdrawal of the rejection of independent claims 77, 86, and 97. Additionally, Applicants respectfully submit that newly added claim 98 is patentable for at least the same reasons as those set forth above in connection with independent claim 77 from which it depends.

The Claims are Non-Obvious Over *Iwata*

Claims 78-82, 84, and 87 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Iwata*. Applicants respectfully traverse this rejection for the reasons set forth below.

Applicants respectfully submit that the claims rejected under 35 U.S.C.§103(a) are patentable for at least the same reasons as those discussed above in connection with their respective independent claims (i.e., independent claims 77 and 86). *Iwata* also fails to suggest additional features of these claims, such as an intended use to provide a restoring force or spring force of any kind.

Additionally, the statement on page 6 of the Office Action that "it would have been obvious... to use the Iwata apparatus... because [it] is capable of performing the intended use or field of use recitations," fails to render the various dependent claims obvious. It is well settled that "the mere fact that the prior art reference may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." In re Fritch, 23 U.S.P.Q. 2d 1780, 1783-4 (Fed. Cir. 1992). Stated another way, just because a reference *could* be modified to include claim elements does not necessarily render those claim elements obvious. Rather, as the Court stated in Fritch, the suggestion of such a modification must come from the prior art. In the present case, it is unclear how the selection of *Iwata* cited on page 6 of the Office Action provides such a suggestion or motivation with regard to each of the individual features of the various dependent claims rejected under 35 U.S.C. §103.

Accordingly, for at least these reasons, Applicants respectfully request the withdrawal of the rejection of dependent claims 78-82, 84, and 87, which each depend from an allowable

independent claim. Additionally, Applicants respectfully request, if the Examiner is to maintain a rejection of these claims for obviousness, that he explain how each of the features of the various dependent claims are rendered obvious by the prior art to properly establish a *prima facie* case of obviousness.

Claims 83 and 85, which contain allowable subject matter, were objected to as depending from a rejected independent claim. However, as pointed out above, independent claim 77 is allowable over the prior art of record. Accordingly, Applicants respectfully submit that the objection to claims 83 and 85 is moot, and these claims should be allowed.

Reasons for Allowable Subject Matter

A statement of reasons for indicating allowable subject matter was set forth by the Examiner. While the Applicants agree that the pending claims are allowable for at least the reasons set forth in the Examiner's Statement, Applicants submit that the invention set forth in the present application is patentable for reasons other than those listed in the Examiner's statement. Accordingly, Applicants reserve the right to pursue claims of different scope than those in the present application.

Conclusion

All rejections and objections having been addressed, Applicants respectfully submit that a Notice of Allowance is next in order, and earnestly solicit such. Should the Examiner have any questions regarding this Amendment, or the Application in general, he is invited to telephone the undersigned at (703) 456-8108.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 50-1283.

Dated: March 11, 2003

Respectfully submitted,
COOLEY GODWARD LLP

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APPENDIX TO AMENDMENT DATED FEBRUARY 11, 2003

Marked-up Amendments to the Specification and Claims

IN THE TITLE

Please replace the title with the following title:

Interactions Between Simulated Objects [using] with Force Feedback.

IN THE ABSTRACT

Please replace the Abstract with the following:

A method and apparatus for providing force feedback to a user operating a human/computer interface device and interacting with a computer-generated simulation. In one aspect, a computer-implemented method simulates the interaction of simulated objects displayed to a user who controls one of the simulated objects manipulating a physical object of an interface device. The position of the simulated object, as provided within the simulation and as displayed, is mapped to the physical position of the user object. This mapping can be broken under conditions that are effective to provide force feedback to the user which imparts a physical sensation corresponding to the interaction of the simulated objects.

Please replace the paragraph starting on page 1, line 6, with:

The present application is a continuation of pending Application No. 09/433,657, filed November 3, 1999 [11/3/99 on behalf of Rosenberg et al.], now Patent No. 6,366,272, which is a continuation of Application No. 08/664,086, filed June 14, 1996, now Patent No. 6,028,593, which is a continuation-in-part of U.S. Patent Application Nos. 08/566,282, filed December 1, 1995, now Patent No. 5,734[.],373; and 08/571,606, filed December 13, 1995, now Patent No.

95. (Amended) The method of claim 94, wherein the opposing force is a spring force, and wherein the friction force has a magnitude associated with a magnitude of the spring force.

96. (Amended) The method of claim 94, further comprising:

simulating a rigidity of the second graphical object by displaying the first graphical object as remaining engaged with the second graphical object when the path of the first graphical object passes through the second graphical object.

97. (Amended) A method, comprising:

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moving a first graphical object in response to movement of at least a portion of a tactile feedback device;

computing a path of the first graphical object based on at least a prior location of the first graphical object;

determining whether the first graphical object has collided with a second graphical object based on the path of the first graphical object in the graphical environment;

displaying the first graphical object as remaining engaged with the surface of the second graphical object when the path of the first graphical object passes through the surface of the second graphical object according to the movement of the portion of the tactile feedback device; and

providing tactile feedback via at least one actuator of the tactile feedback device, the tactile feedback corresponding with the displayed interaction between the first graphical object and the second graphical object.

91. (Amended) The method of claim 90, wherein the network is the World Wide Web.

92. (Amended) The method of claim 86, wherein the outputting the force feedback signal includes outputting a friction force to the first force feedback device when at least a portion of the first force feedback device is moved in a direction corresponding to a direction approximately perpendicular to the path of the first graphical object while the first and second graphical objects are engaged.

93. (Amended) The method of claim 92, wherein the opposing force is a restoring spring force, and the friction force has a magnitude associated with a magnitude of the restoring spring force.

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94. (Amended) A method, comprising:

moving a first graphical object in response to movement of at least a portion of a force feedback device;

determining whether the first graphical object has engaged a second graphical object based on path of the first graphical object in the graphical environment, the path determined at least in part by a previous location of the first graphical object; and

providing force feedback via at least one actuator of the force feedback device coupled to a host computer the force feedback including

an opposing force on the force feedback device, the opposing force causing at least a portion of the force feedback device to move in a direction approximately opposite to the path of the first graphical object while the first graphical object is engaged with the second graphical object; and

a friction force on the force feedback device, the friction force causing at least a portion of the force feedback device to move in a direction corresponding to a direction approximately perpendicular to the path of the first graphical object while the first graphical object is engaged with the second graphical object.

6,219,032; and where said Application No. 08/664,086 claims the benefit of provisional [a]Application No. 60/017,803, filed May 17, 1996; all of which are incorporated herein by reference [for all purposes] in their entireties.

Please replace the paragraph starting on Page 33, line 21, with:

Embodiments using a local microprocessor 26 to implement reflex processes is described by [copending parent applications 08/534,791, filed September 27, 1995 on behalf of Rosenberg, entitled "Method and Apparatus for Controlling Human-computer Interface Systems Providing Force Feedback, and U.S. patent application Serial no. 08/566,282, entitled "Method and Apparatus for Controlling Force Feedback Interface Systems Utilizing a Host Computer," filed 12/1/95 on behalf of Louis B. Rosenberg et al.,] Patent Nos. 5,739,811 and 5,734,373, both assigned to the assignee of this present application, and both hereby incorporated by reference herein in their entireties.

Please replace the paragraph starting on Page 40, line 11, with:

An interface apparatus providing two linear (X and Y) degrees of freedom to user object 34 as well as a rotating ("spin") third degree of freedom about a Z axis is quite suitable for the paddle-ball implementation. Linear degree of freedom apparatuses are disclosed in [co-pending applications serial no. 08/489,068, and serial no. 08/560,091] Patent Nos. 5,721,566 and 5,805,140, previously incorporated herein, and further embodiments of such are described below.

<u>IN THE CLAIMS:</u>

Please amend the claims as follows:

77. (Amended) <u>Processor-executable code,</u> [A computer readable medium including program instructions for simulating the spatial interaction of a displayed first simulated object with a displayed second simulated object in a computer-simulated spatial environment such that the user is provided with a force feedback that realistically represents said interaction, said program instructions performing the following on a computer system] <u>comprising</u>:

[executing a simulation including a first simulated object, said simulation being configured to implement the motion of said first simulated object in response to motion of a physical object of an interface device controlled by a user, wherein said object has a physical position in a physical workspace, and wherein a position control mapping between said simulated location of said first simulated object and said physical position of said physical object exists, said simulation being further configured to generate]

<u>code to determine a trajectory of a first simulated object, the trajectory associated with prior positions of the first object, simulated motion of the first simulated object being associated with motion of a physical object of a computer interface device;</u>

<u>code to simulate</u> a second simulated object [having boundaries such that said second simulated object] <u>configured to</u> impede[s] the simulated motion of [said] <u>the</u> first simulated object when the trajectory of [said] <u>the</u> first simulated object intersects [said] <u>the</u> [boundaries of said] second simulated object;

<u>code to display a simulated interaction between</u> [providing information causing a display device to display the location and motion of said] <u>the</u> first simulated object and [said] <u>the</u> second simulated object [such that when said first simulated object and second simulated object collide, the first simulated object is displayed at the boundary of the second simulated object as if unable to substantially penetrate said second simulated object, even if the motion of said physical object would indicate that a penetration should occur with respect to the position control mapping]; and

code to provide [providing information causing] a force feedback via a force feedback mechanism, the force feedback being [to impart to a user of said force feedback mechanism a physical sensation that corresponds to] associated with the simulated [physical] interaction of [said] the first simulated object with [said] the second simulated object [when the trajectory of said first simulated object intersects the boundaries of said second simulated object].

78. (Amended) The [computer readable medium] processor-executable code of claim 77, wherein [said] the [physical sensation] code to provide a force feedback includes code to provide a restoring force that is proportional to [an amount] a magnitude of a simulated penetration of the first simulated object and the second simulated object [said penetration of said second simulated object].

79. (Amended) The [computer readable medium] processor-executable code of claim 78, wherein [said] the restoring force includes a spring force having the mathematical form:

$$F = kx$$

where F is [said] the restoring force, x is a magnitude of a deviation of [said] the spatial correlation including a deviation between the current location of the first simulated object and a location of [said] the first simulated object had [said] the [mapping not been broken,] simulated penetration occurred and k is a spring constant parameter.

80. (Amended) The [computer readable medium] processor-executable code of claim 79, wherein [said] the restoring force includes a damping force and [said] the restoring force has the mathematical form:

$$F = kx + bv$$

where F is [said] <u>the</u> restoring force, x is a magnitude of a deviation of [said] <u>the</u> spatial correspondence including a deviation between the current location of the first simulated object and a location of [said] <u>the</u> first simulated object had [said] <u>the</u> [mapping not been broken] <u>simulated penetration occurred</u>, v is a function of a velocity of [said] <u>the</u> physical object, and k and b are constant parameters.

81. (Amended) The [computer readable medium] <u>processor-executable code</u> of claim 80, wherein [said] <u>the</u> restoring force includes an [intertial] <u>inertial</u> force corresponding to [the] movement of [said] <u>the</u> second simulated object in response to [said] <u>the simulated</u> interaction between [said] <u>the</u> second simulated object and [said] <u>the</u> first simulated object and [said] <u>the</u> restoring force has the mathematical form:

$$F = kx + bv + ma$$

where F is [said] <u>the</u> restoring force, x is a magnitude of a deviation of [said] <u>the</u> spatial correspondence including a[.] deviation between the current location of the first simulated object and a location of [said] <u>the</u> first simulated object had [said] <u>the</u> [mapping not been broken] <u>simulated penetration occurred</u>, v is a function of a velocity of [said] <u>the</u> physical object, a is a function of an acceleration of [said] <u>the</u> physical object, and k, b and m are constant parameters.

82. (Amended) The [computer readable medium instructions] <u>processor-executable code</u> of claim 78, wherein [said] <u>the code to provide the</u> restoring force includes a component <u>associated with</u> [resulting from] friction between [said] <u>the first</u> simulated object and [said] <u>a</u> simulated spatial environment.

83. (Amended) The [computer readable medium] <u>processor-executable code</u> of claim [78] <u>77</u>, wherein <u>the code to simulate</u> [said] <u>the</u> second simulated object [moves on said display device during said simulation] <u>is associated with</u> [in response to manipulations] <u>motion</u> of a second physical object of a second <u>computer</u> interface device [by said second user, said second

interface device being coupled to a second computer system coupled to said computer system through a network interface].

84. (Amended) The [computer readable medium] processor-executable code of claim 78, wherein [said] the code to provide the restoring force includes a weighting factor such that [the] a simulated location L [on said display device] of the first and second simulated objects is output [shown] on [said] a display [device is], the location L being determined by the equation:

$$L=\frac{(w_1x_1+w_2x_2)}{(w_1+w_2)}.$$

85. (Amended) The [computer readable medium] processor-executable code of claim 77, the interface device being a first interface device wherein [said] the code to simulate the motion of the first simulated object is associated with a first processor, and the code to simulate the second object is associated with a second processor [is coupled with a second processor executing said simulation, said] the second processor being [responsive to] associated with input from a second interface device, [said] the first processor[s] and the second processor being coupled such that [said simulations communicate] input signals [information] from [said] the first interface device[s] are associated with input signals from the second interface device.

86. (Amended) A method, [for providing an interaction between displayed objects in a graphical environment implemented by a host computer, wherein a user interfaces with said graphical environment using a force feedback device coupled to said host computer, the method] comprising:

[moving] updating data values associated with a first graphical object [in response to] based on movement of [a] at least a portion of a force feedback device [manipulatable object of said force feedback device by said user, said movement of said first graphical object provided according to said movement of said user manipulatable object];

determining whether [said] the first graphical object has engaged a second graphical object [by examining] based on a path of [said] the first graphical object associated with a prior

position of the first graphical object [in said graphical environment, said path determined [by examining]based on a current location of said first graphical object and a previous location of said first graphical object];

[providing an illusion of rigidity of said second graphical object by] displaying in a graphical environment [said] the first graphical object as remaining engaged with [said] the second graphical object [when said] if it is determined that the path of [said] the first graphical object [has been determined to move] passes through [said] the second graphical object [according to, said movement of said user manipulatable object]; and

outputting a [providing information that causes said] force feedback signal to at least one actuator of the force feedback device [coupled to said host computer to output], the force feedback signal being operative to output an opposing force on at least a portion of [said] the [user manipulatable object] force feedback device [by at least one actuator in said force feedback device] in a direction approximately opposite to [said] the path of [said] the first graphical object while [said] the first graphical object [is engaged with] engages [said] the second graphical object.

87. (Amended) [A] The method [as recited in] of claim 86, wherein [said] the opposing force is a restoring spring force.

88. (Amended) [A] The method [as recited in] of claim 86, wherein at least a portion of [said] the second graphical object is fixed in location within [said] the graphical environment.

89. (Amended) [A] The method [as recited in] of claim 86, [wherein said user is a first user, and wherein] the force feedback device being a first force feedback device, the method further comprising:

updating data values associated with [said] the second graphical object [is moveable according to input from a second user] based on movement of at least a portion of a second force feedback device [coupled to said host computer].

90. (Amended) [A] The method [as recited in] of claim 89, wherein [said] the [host computer is] first force feedback device is coupled to a first host computer, and [wherein said] the second force feedback device is coupled to a second host computer, the second host computer being [which is] coupled to [said] the first host computer via a network connection.

91. (Amended) [A] The method [as recited in] of claim 90, wherein [said] the network is the World Wide Web.

92. (Amended) [A] The method [as recited in] of claim 86, wherein the outputting the force feedback signal includes outputting a friction force [is output] to the first force feedback device [on said user manipulatable object when said user manipulatable object] when at least a portion of the first force feedback device is moved in a direction corresponding to a direction approximately perpendicular to [said] the path of [engagement of] [said] the first graphical object while [said] the first and second graphical objects are engaged.

93. (Amended) [A] The method [as recited in] of claim 92, wherein the opposing force is a restoring spring force, and [said] the friction force has a magnitude associated with [that is a function of said] a magnitude of [said] the [opposing] restoring spring force.

94. (Amended) A method, [for providing an interaction between displayed objects in a graphical environment implemented by a host computer, wherein a user interfaces with said graphical environment using a force feedback device coupled to said host computer, the method] comprising:

[(a)] moving a first graphical object in response to movement of at least a portion of a [user manipulatable object of said] force feedback device[by said user, said movement of said first graphical object provided according to said movement of said user manipulatable object];

[(b)] determining whether [said] the first graphical object has engaged a second graphical object [by examining]based on a path of [said] the first graphical object in [said] the graphical

environment, [said] the path determined at least in part [by examining]based on a previous location of [said] the first graphical object; and

[(c)] providing [information that causes said] force feedback via at least one actuator of the force feedback device coupled to [said] a host computer [to output] the force feedback including[:]

[(i)] an opposing force on [said] the [user manipulatable object] force feedback device [by at least one actuator in said force feedback device when], the opposing force causing at least a portion of [said] the [user manipulatable object] force feedback device to move [is moved] in a direction approximately opposite to [said] the path of [said] the first graphical object while [said] the first graphical object is engaged with [said] the second graphical object; and

[(ii)] a friction force on [said] the [user manipulatable object] force feedback device [by at least one actuator in said force feedback device when], the friction force causing at least a portion of [said] the [user manipulatable object] force feedback device to move [is moved] in a direction corresponding to a direction approximately perpendicular to [said] the path of [engagement of said] the first graphical object while [said] the first graphical object is engaged with the [and] second graphical object[s are engaged].

95. (Amended) [A] The method [as recited in] of claim 94, wherein [said] the opposing force is a spring force, and wherein [said] the friction force has a magnitude associated with [that is a function of said] a magnitude of [said] the [opposing] spring force.

96. (Amended) [A] The method [as recited in] of claim 94, further comprising [breaking said position control mapping and]:

[providing an illusion of] simulating a rigidity of [said] the second graphical object by displaying [said] the first graphical object as remaining engaged with [said] the second graphical object when [said] the path of [said] the first graphical object [has been determined to move]

passes through [said] the second graphical object [if said position control mapping were maintained].

97. (Amended) A method, [for providing an interaction between displayed objects in a graphical environment implemented by a host computer, wherein a user interfaces with said graphical environment using a tactile feedback device coupled to said host computer, the method] comprising:

moving a first graphical object in response to movement of [a user manipulatable object of said force]at least a portion of a tactile feedback device[by said user, said movement of said first graphical object provided according to said movement of said user manipulatable object];

computing a path of the first graphical object based on at least a prior location of the first graphical object;

determining whether [said] the first graphical object has collided with a second graphical object[by examining a] based on the path of [said] the first graphical object in [said] the graphical environment;

[providing an illusion of rigidity of said second graphical object by] displaying [said] the first graphical object as remaining engaged with the surface of [said] the second graphical object when [said] the path of [said] the first graphical object [has been determined to move] passes through the surface of [said] the second graphical object according to [said] the movement of portion of the tactile feedback device[said user manipulatable object]; and

providing [information that causes said] tactile feedback via at least one actuator of the tactile feedback device [coupled to said host computer to output a sensation felt by said user, produced by at least one actuator in said tactile feedback device], the tactile feedback corresponding with the displayed interaction between [said] the first graphical object and [said] the second graphical object.